DOCUMENT RESUME

ED 322 709 FL 018 615

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TITLE A Level-of-Question Effect on ESL Reading Comprehension.
PUB DATE 90
NOTE 30p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Cognitive Processes; *English (Second Language); Language Research; Language Tests; *Questioning Techniques; *Reading Comprehension; Student Evaluation; Test Format
IDENTIFIERS *Japanese Speaking; *Southern Illinois University Carbondale

ABSTRACT

A sample of 150 Japanese English-as-a-Second-Language students at Southern Illinois University, Carbondale was given a reading comprehension test containing three levels of questions: factual, generalization, and inference, to measure comprehension effects at different proficiency strata. The results indicated that there were significant differences among the proficiency strata for the factual questions, but no significant differences among the generalization and inference levels of questions. An explanation for the compacted scoring distributions and resultant lack of significant differences among the proficiency strata is that the generalization and inference levels of questions required more short term memory ability, the attention and recall of more textual material, and more elaboration and rehearsal than the samples' target language competence could accommodate. In other words, the questions presented a processing overload. Sample test passages and reading probes are appended. The document contains 16 references and 7 figures. (Author/GLR)

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A Level-of-Question Effect on ESL Reading Comprehension

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A Level-of-Question Effect on ESL Reading Comprehension

Abstract

This study examined the effects of different levels of questions on the reading comprehension performance of three samples of ESL readers at different proficiency strata. In this context the term, level of question, refers to the level of cognitive processing required to answer a question. The reading comprehension test employed in this research contained three levels of questions: factual, generalization, and inference.

The results indicated that there were significant differences among the proficiency strata for the factual questions, but no significant differences obtained among the different proficiency strata for the generalization nor the inference levels of questions. A plausible explanation for the compacted scoring distributions and resultant lack of significant differences among the proficiency strata is that the generalization and inference levels of questions required more short term memory; the attention and recaall of more textual material; more strategies and processing; and more elaboration and rehearsal than the samples' target language could accomodate. In other words, the questions presented a processing overload.

A Level-of-Question Effect on ESL Reading Comprehension

This paper reports the results of a study whose purpose was to determine whether different levels of questions had a differential effect on ESL reading comprehension at different levels of proficiency. The term, level-of-question, "refers to the nature of cognitive processing required to answer a question" (Andre, 1979, p.282). A level-of-question effect is related to the depth-of-processing hypothesis which argues "that presented information may be processed to a greater or lesser depth along a continuum ranging from superficial processing of perceptual features to processing for the meaning of the information" (Andre, 1979, pp. 280-1). According to Andre (1979), the hypothesis that different levels of questions differentially influence attained reading comprehension is based on a further hypothesis that different levels of questions influence the nature of the memory representations which are formed during the reading process and, further, that the memory representations determine and control the manner in which such stored knowledge structures can be utilized.

The level-of-question research paradigm concerns the types of cognitive processing which readers engage while they answer reading comprehension questions. Research has shown that factual questions require more simple cognitive processing than questions which require more than direct memory (Anderson, 1972; Ausubel, 1963).

Andre (1979) noted that "factual questions typically ask the reader to supply or recognize some item of information given in the passage. Factual questions are typically primarily verbatim. Types of information requested have included names, numbers, dates, definitions, terms, etc." On the other hand, Andre stated that an inference question "requires a reader to state a relationship between elements of the passage that is implied but not explicitly stated in the passage" (p.282).

Anderson (1972) argued that a reader could correctly answer a verbatim factual question without a modicum of comprehension "by matching its elements with the surface orthographic or phonological features of the original communication" (p.150). It is hypothesized that questions which must be processed at a deeper level than at the direct memory level require that the reader attend to more of the passage and to recall more of the passage. Most of the level-of-question research has compared readers' performance on factual knowledge questions with their performance on various combinations of deeper- (than verbatim factual knowledge) level questions.

The Present Study

The present study sought to determine whether different levels of questions had a differential effect on ESL reading comprehension at different levels of proficiency. Three different levels of questions were utilized: factual, generalization, and inference. In truth there may have been only two distinct levels

of questions - factual and deeper than factual - because it may not be possible at the moment to distinguish in a vigorous systematic way between the depths and the levels of processing entailed by generalization and inference questions.

The research hypothesis was that there would be significant differences in performance on the different levels of questions by the three groups of subjects at different proficiency levels. The basis for the research hypothesis was that as attained ESL proficiency of the subjects increased, their reading comprehension ability would increase; their guessing and predicting ability would increase; and their short-term memory would increase, thereby making the readers' recollection of previous graphophonemic, morphemic, syntactic, and semantic cues less difficult (cf. Yorio,1971).

Method

Subjects

The subjects for this study were 150 Japanese students enrolled in the intensive English program of Southern Illinois University at Carbondale in Niigata, Japan. The method of selection was the natural assembly process. All subjects who sat for the examinations were included in the sample: no aberrant or skewed data were purged from the data set which was analyzed and reported.

The subjects were placed into three different proficiency

strata by an independent measure, an institutional TOEFL test. Students who scored up to 373 on the TOEFL were placed into proficiency level 1, n=32; students who scored from 377 to 427 were placed into proficieny level 2, n=106; students who scored from 430 to 467 were placed into proficiency level 3, n=20. These placement intervals were established by the intensive English language program and were not available for manipulation by the investigators. At the time when these data were collected, the students had received five hours of weekly reading instruction over a period of 27 weeks, or three terms of instruction.

Instrumentation

Two fifty-item random parallel reading comprehension tests were constructed as the elicitation instruments for this study. Random parallel tests are composed of items "drawn randomly from the same population of items. Tests are said to be randomly parallel when the same numbers of items with equivalent content are randomly drawn from a pool of such items" (Henning, 1987, pp. 81-82). One of the tests was translated into Japanese and is referred to as the L1 (=first-language) test. The L1 test's instructions, reading passages, questions, and responses were in Japanese. The other test, the L2 test, was totally in English.

By constructing random parallel tests we hoped to hold all factors constant in both tests, save for the language. The content of the passages in both tests reflected similar subject

matter; the readability level for both tests was the same, grade 10, estimated by the McLaughlin (1969) method; the same skills were assessed by both tests -- facts, generalizations, and inferences; and finally, any bias in content and schemata (Carrell,1987) was held constant in both tests. That is, any bias -- positive or negative for Japanese readers-- in subject matter and text properties remained constant in both texts.

The L1 test contained 18 factual items; 16 generalization items; and 16 inference items; the L2 test contained 15 factual items; 20 generalization items; and 15 inference items.

(Put Appendix A about here)

Appendix A presents a representative reading passage and three example probes. All items were multiple-choice with three distractors and a keyed response. Each correct response was accorded one point, and for each subject the total number of correct responses for each level of question -- factual, generalization, and inference-- was converted to a percentage correct and entered for analysis.

The factual items required the subjects to recognize literally stated factual details; the generalization items required the subjects to evaluate the reading passages and to generalize from them; the inference items entailed the inferring and interpretation of underlying relationships. The factual questions asked <u>who?</u>, <u>what?</u>, <u>when?</u>, and <u>where?</u> The generalization questions involved evaluative meaning. The inference questions were <u>why?</u> questions.

During the testing sessions, the L1 and L2 tests were counterbalanced to attempt to preclude response set.

Analysis

The analysis of covariance -- ANCOVA -- was employed for data analysis (Winer, 1971, p. 752). The purpose of this particular study was to determine whether different levels of questions--factual, generalization, and inference -- produced differential effects on ESL reading comprehension at different levels of proficiency estimated by the TOEFL, when the initial differences in the readers' first-language reading comprehension are controlled for by the ANCOVA procedure.

In this study the independent variable was the proficiency levels of the subjects; the dependent variable was the second-language reading comprehension measures, i.e. the different levels of questions; and the covariate was the first-language reading comprehension measures, i.e., the different levels of questions. The focus of the study was the relationship between the second-language reading comprehension measures and the proficiency levels of the subjects.

The ANCOVA procedure adjusts the dependent variable (the second-language reading comprehension measures) for the concomitant variation in the covariate (the first-language reading comprehension measures) and thus hypothetically

represents what might have been seen in the second-language reading comprehension measures if all groups had been equal in terms of first-language reading comprehension ability. The procedure detects differences in the dependent variable over the various levels of the independent variable and adjusts the dependent variable for the value of the covariate for each observation thereby removing the extraneous variation from the dependent variable and increasing the precision of the analysis. It is possible to assess the influence of the independent variable more accurately if the variance in the dependent variable which is associated with the covariate is partitioned out. The magnitude of gain in precision of measurement from the utilization of the covariance adjustment depends upon the magnitude of the correlation between the covariate and the dependent variable. If the correlation is substantial, as it was for proficiency level 2 L1-L2 factual and L1-L2 inference and for proficiency level 3 L1-L2 inference and for L1-L2 generalization, then the amount of variation attributable to the covariate is likely to be high. In such cases, as in this study, the ANCOVA will be highly effective in reducing error variance.

In an ANCOVA involving more than two levels in the independent variable, a significant F-ratio for group effects indicates that one of the groups differs from another group. When a significant F-ratio is found, it is a customary practice to compute adjusted group means -- adjusted for the covariate -- and to determine which pairs of adjusted group means are

significantly different.

Results

(Put Table 1 about here)

Table 1 presents the mean percentages correct for the different levels of questions for the L1 and L2 tests at the three levels of proficieny as estimated by the institutional TOEFL.

(Put Tables 2,3,and 4 about here)

Analysis of covariance (ANCOVA) were performed to test for level differences on the L2 measures covarying for the corresponding L1 measures. A separate ANCOVA was performed for each of the three measures--L2 factual; L2 generalization; and L2 inference. Preliminary tests for homogeneity of regression were also performed.

The assumption of homogeneity of regression was found to be tenable. No significant differences of the L2 to L1 regressions were found for any of the measures. The homogeneity of regression issue means that the slope of the regression line (predicting the L2 measures from the L1 measures) was the same for the three proficiency- level groups under study; that is, the regression lines for each group were parallel indicating that the incremental impact of the covariate was the same for all groups.

As Table 2 indicates, only the L2 factual (F=7.15,

d.f.=2,154, $p < .01$) ANCOVA was significant . The adjusted means for the significant dependent variable were highest in proficiency level 3--TOEFL interval 430-467-- with proficiency level 2--TOEFL interval 377-427-- and proficiency level 1--TOEFL interval 373 and below-- following in descending order. Post hoc tests on the adjusted means for the L2 factual ANCOVA showed all three proficiency levels to be significantly different ($p < .05$).

Tables 3 and 4 indicate that the adjusted means for the dependent variable were highest in proficiency level 3 with proficiency levels 2 and 1 following in descending order; however, for L2 generalization and L2 inference, not one of the three levels was significantly different from another, for the F-ratios were not significant.

Discussion

The research hypothesis that there would be significant differences in the readers' performance on the different levels of questions by the three groups of subjects at different proficiency levels was only partially confirmed; only a significant difference between the proficiency levels was found for the factual leval of questions. No significaant differences between proficiency levels was found for the generalization and inference levels of questions. We believe that these findings can be explained with reference to the following factors: 1) the amount of cognitive processing entailed by the level of question;

2) the amount of textual material to be attended to and to be recalled entailed by the level of question; 3) the different strategies entailed by the level of question; and 4) the amount of short term memory required by the level of question.

To answer factual questions like the example probe in Appendix A, the readers could have used their direct memory to match the question's keyed response with the surface graphophonemic or phonological features of the original text. Answering this factual question amounts to little more than a template-matching exercise, i.e., matching one of the responses and the question stem to a verbatim statement in the passage.

(Put Figures 1 and 2 about here)

Figures 1 and 2 attempt to portray the retrieval strategy and memory representation generated by the example factual question. The question "What color will you see as you dive below the gray level?" leads to a strategy in which "color encountered below the gray level" or color-level doublet becomes a criterion for selecting and retrieving information. Presumably the various levels and the colors associated with the next lower level are stored until the correct color-level doublet is found. The color level retrieval cue is associated to the color-level doublets in the passage. To answer this question the readers must focus on only the color-level data. Because this level of question can be answered by matching the keyed response to the original wording in the text, only simple direct memory is engaged, and thus the readers' short term memory is not overly taxed. The results of

the ANCOVA indicate that the readers' ability to answer factual verbatim questions significantly increased as their proficiency level increased. Yorio (1971) would have argued that as the readers' proficiency increased, their guessing and predicting ability increased; their ability to make correct choices of cues and associations increased; and their correct recollection of previous cues increased.

Our explanation for the lack of significant differences between the proficiency levels on the generalization and inference levels of questions is that these two levels of questions required levels of processing in the target language, the attention to and recall of a large quantity of textual material, and a short term memory capacity in the target langauge that was beyond the ability of the subjects because of their imperfect and developing competence in English. The sample examined in this study exhibited a restricted range of proficiency given the fact that a TOEFL score of 525-550 is generally required for undergraduate admission to most universities. A result of the sample's restricted proficiency is a compaction of scores toward the lower end of the scoring continuum for the L2 generalization and inference measures in comparison to the L2 factual measures, and especially in comparison to the L1 measures (Table 1). The compaction and restricted distribution of the least squares means for the L2 generalization and inference measures is even more acute and pronounced (Tables 3 and 4).

(Put Tables 3 and 4 about here)

Figure 3 presents the effects of the question, "What is the best title for this essay?", which entails the use of a different set of criteria for the selection of information for encoding. Figure 4 illustrates the resulting memory representation. Figure 3 is highly oversimplified because the reader must generalize a general theme, thesis or topic (composition terms) from each sentence of the essay (assuming the essay manifests coherence and cohesion) and store each relevant piece of information. After all the subject matter-title matches have been stored, the readers must use previous knowledge of subject matter-title relationships and previous reading experience to determine which of the four proposed titles is the most appropriate.

It is highly unlikely that the sample were able to encode and retrieve all the information germane to the question, because the entire passage was relevant. In addition to the constraints imposed by a finite processing capacity even further reduced by a limited short term capacity in the target langauge, the readers may have also used incorrect retrieval strategies thus encoding and retrieving the incorrect information.

(Put Figures 5 and 6 about here)

Figures 5 and 6 illustrate the retrieval strategy and memory representation generated by the question, "What is the most important factor that accounts for color changes in the ocean as you dive deeper and deeper?" This question required the readers

to attend to the entire passage. Each mention of a color term must have been stored together with the cause of each change. An inspection of the reading passage indicates that there is an implicit cause-and-effect relationship which must be inferred. After the cause-and-effect doublets had been stored, the readers had to determine the appropriateness of each causative factor mentioned in the options and then determine the most (only) important causative factor.

The attention and encoding demands illustrated in Figure 5 are similar in complexity to those illustrated in Figure 3. The entire passage is relevant; the readers had to ascertain that the question sought a cause-and-effect relationship; each sentence had to be analyzed to determine if it mentioned (implicitly or explicitly) a cause for color change. After all the cause-and-effect doublets had been stored, the readers were then required to use previous knowledge and reading experience to determine the most important cause for color changes.

We believe that the generalization and inference levels of questions required cognitive processing and short term memory loads in English that were beyond the reach of the sample. As a result of their developing competence, the sample found these levels of questions very difficult to process and thus their scores were compacted toward the lower end of the scoring continuum. The effect of this compaction of scores was that no significant differences were obtained across proficiency levels.

(Put Figure 7 about here)

To explicate the relationship between memory capacity and productive learning it is necessary to examine how the basic human memory system hypothetically operates. According to Andre (1979) an educational task like reading for meaning entails changes in the readers' semantic memory. For this sample the necessary input to answer correctly the generalization and inference questions may never have reached the readers' semantic memory (a component of long term memory) through the sensory and short term memories.

According to Lerner et. al. (1986) the sensory memory preserves environmental information long enough for sorting to occur. Sensory information is lost from the sensory stores by decay or interference if it is not processed further.

In short term memory, conscious mental processes are performed on the information resulting in its being encoded and stored. Conrad's (1964) research suggests that verbal material which is presented visually is often coded acoustically; that is, printed material which is read may be coded acoustically. Under optimum conditions it is possible to attend to only five to nine items (Miller, 1956).

To summarize, there are several reasons attributable to the samples' short term memory to explain why the sample were not able to process generalization and inference questions effectively. First, their short term memory was not as extensive in the target language as in their native language. Second, there is the possibility of first-language interference because

visually-presented verbal material is often acoustically coded. Third, because of the samples' imperfect command of English the magical number of items which they could attend to may have been smaller than "seven plus or minus two."

The function of the long term memory is to maintain information which is no longer in one's consciousness. There are two types of long term memory: episodic memory for specific events and semantic memory for general knowledge (Tulving, 1972). According to Andre (1979) an educational task like reading for meaning requires changes in semantic memory which is best represented by a network containing catalogued procedures, nodes, and labled connections between nodes. "A new node (and capability) is developed in semantic memory through a two-stage process in which first, relevant episodes are laid down in episodic memory and associated with a node label, and, second, the learner attempts to perform some task involving the node and the results of the processing performed in the task are connected to the node in semantic memory" (Andre, 1979, p.302).

In long term memory information can be encoded phonologically, semantically, or visually, but the preferred encoding for verbal material is semantic (Bransford and Franks, 1971). Another explanation for the effective retention of material in long term memory is deep processing and elaboration (Craik, 1981) which may be achieved by rehearsal (Craik and Watkins, 1973) and by organization (Mandler, 1967).

Given the fact that the readers were required to devote

attention to large amounts of text and to engage complex processing strategies to answer the generalization and inference questions, the necessary changes in their semantic memory may not have been effectd even if the requisite information managed to get transferred from short term memory for a number of reasons. First, there may have been difficulties in laying down the relevant episodes in episodic memory. Second, relevant nodes may not have even existed especially if the readers had had no previous experience or knowledge of color changes in the ocean. Third, imperfect control of the target language and first-language interference almost assuredly guaranteed difficulties with semantic and phonological coding. Fourth, readers may not have had the necessary cognitive and metacognitive training and practice in deep processing, elaboration, and organization strategies.

In summary we sought to determine whether there would be significant level-of-question effects on ESL reading comprehension at different levels of attained English target language proficiency. We found significant differences among the proficiency levels on factual questions. The highest proficiency level correctly answered more factual questions than the second highest group who in turn answered more faactual questions than the lowest proficiency level at the .05 level of significance. A logical explanation is that as the readers' proficiency level increased their ability to predict, to make the necessary associations, and to recall the previous cues to answer factual

questions correctly also increased. No significant differences across the proficiency levels were noted for the generalization and inference levels of questions. A possible explanation is that these levels of questions required (for answering correctly) more short term memory, the attention and recall of more textual material, more strategies and processing, and more elaboration and rehearsal than the readers' target language competence could accomodate.

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Appendix A

Sample passage and reading probes

This is what you will see (or not see) if you travel far below the surface of the ocean in a bathyscaph, which is a deep-sea diving apparatus for reaching great ocean depths without a cable. Basically you will notice that colors change as you descend deeper into the ocean.

While you are near the surface, the colors will appear normal, much as they appear on the surface. As you dive deeper in the bathyscaph, the warm colors will begin to disappear because you are no longer able to see any reds,oranges, and yellows.

As you travel downward to even greater depths, you will see only the blues and the purples, but even these colors will begin to disappear as you plunge to greater depths.

After the blues and the purples have disappeared at greater depths, you will see only gray because the enormous depth of the water between you and the surface has filtered out the rainbow assortment of colors associated with the sun.

Below the gray level, you will see only black because you will be so deep that no light can penetrate the depths to reach you. By now you will be most anxious and eager to return to the surface again where you can enjoy a constantly changing kalaidoscope of colors and patterns.

What color will you see as you dive below the gray line?

A) Green
B) Red
C) Black
D) Yellow
(Fact)

What is the best title for this essay?

A) "Colorful Deep Sea Plants"
B) "Diving in the Ocean"
C) "Ocean Colors: Changes in the Deep"
D) "Terror in the Ocean"
(Generalization)

What is the most important factor that accounts for color changes in the ocean as you dive deeper and deeper?

A) The current of the water
B) The depth of the water
C) The direction of the water
D) The temperature of the water
(Inference)

Figure 1

Retrieval strategy (and reading strategy if text is available) generated in response to the question, "What color will you see as you dive below the gray level?"

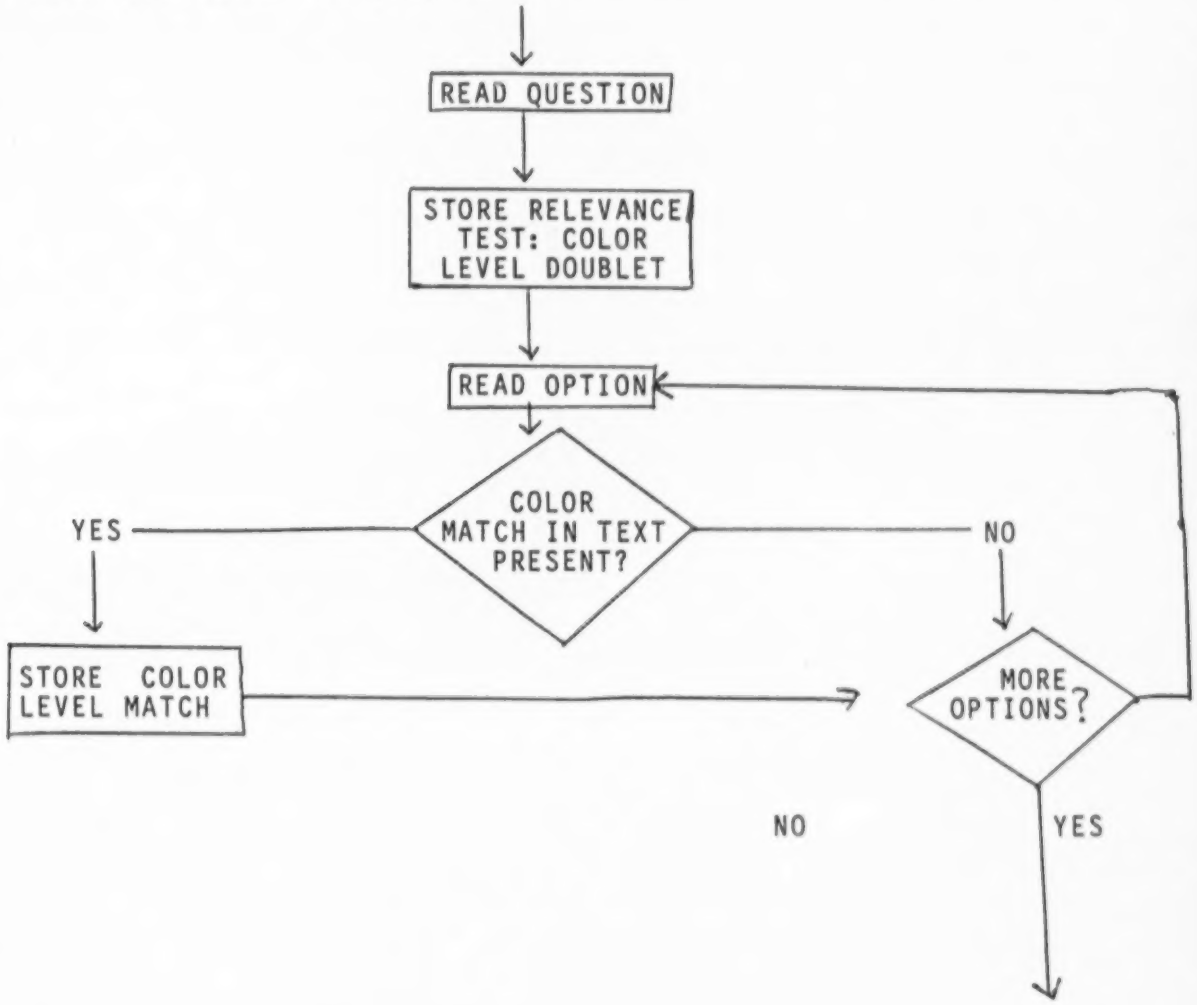


Figure 2

Memory presentation generated by the question,"What color will you see as you dive below the gray level?"

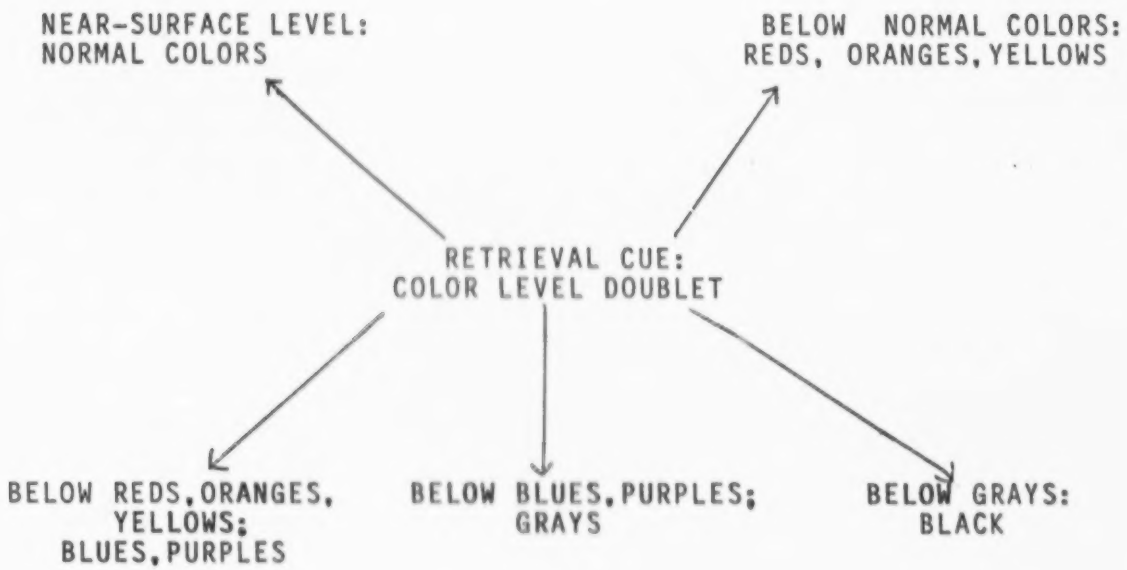


Figure 3

Retrieval strategy (and reading strategy if text is available) generated in response to the question, "What is the best title for this essay?"

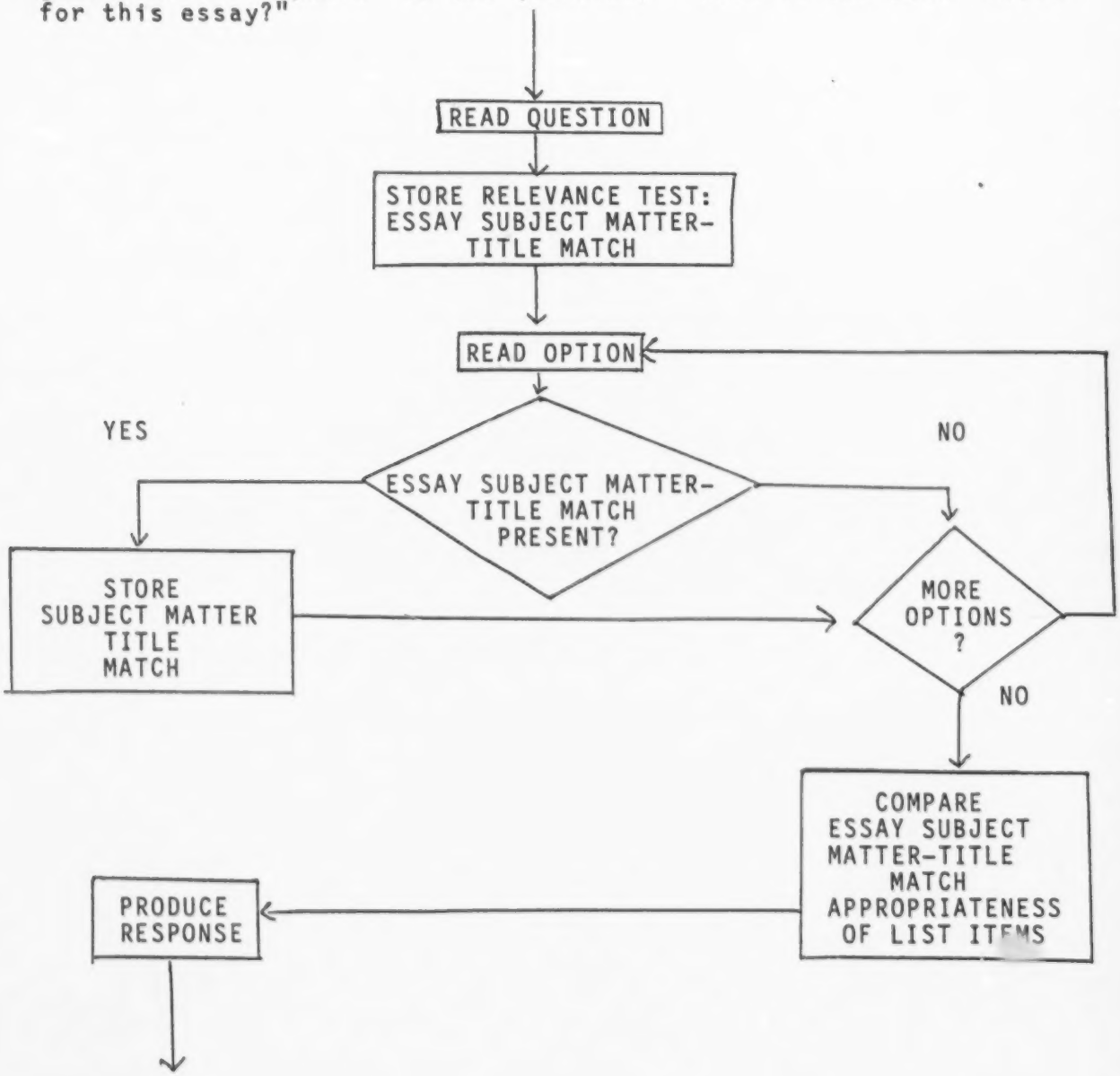


Figure 4

Memory representation generated by the question, "What is the best title for the essay?

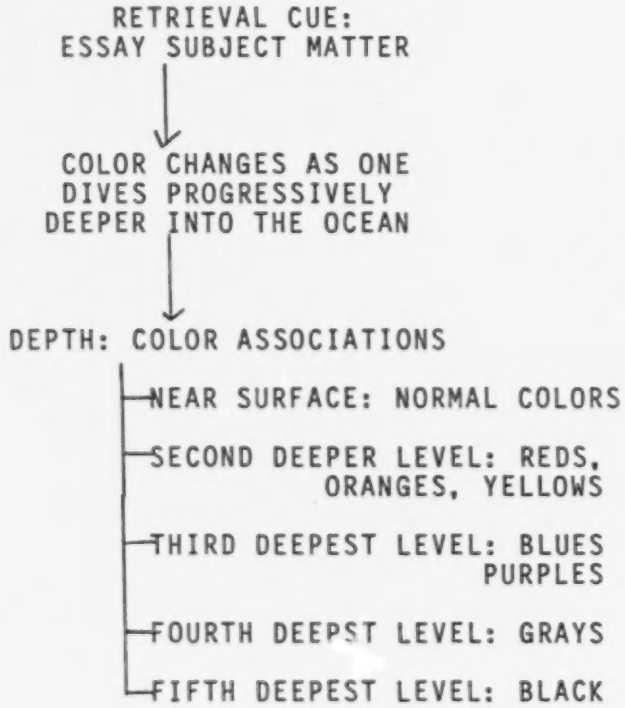

RETRIEVAL CUE:
ESSAY SUBJECT MATTER
COLOR CHANGES AS ONE DIVES PROGRESSIVELY DEEPER INTO THE OCEAN
DEPTH: COLOR ASSOCIATIONS
NEAR SURFACE: NORMAL COLORS
SECOND DEEPER LEVEL: REDS, ORANGES, YELLOWS
THIRD DEEPEST LEVEL: BLUES PURPLES
FOURTH DEEPST LEVEL: GRAYS
FIFTH DEEPEST LEVEL: BLACK

Figure 5

Retrieval strategy (and reading strategy if text is available) generated in response to the question, "What is the most important factor that accounts for color changes in the ocean as you dive deeper?"

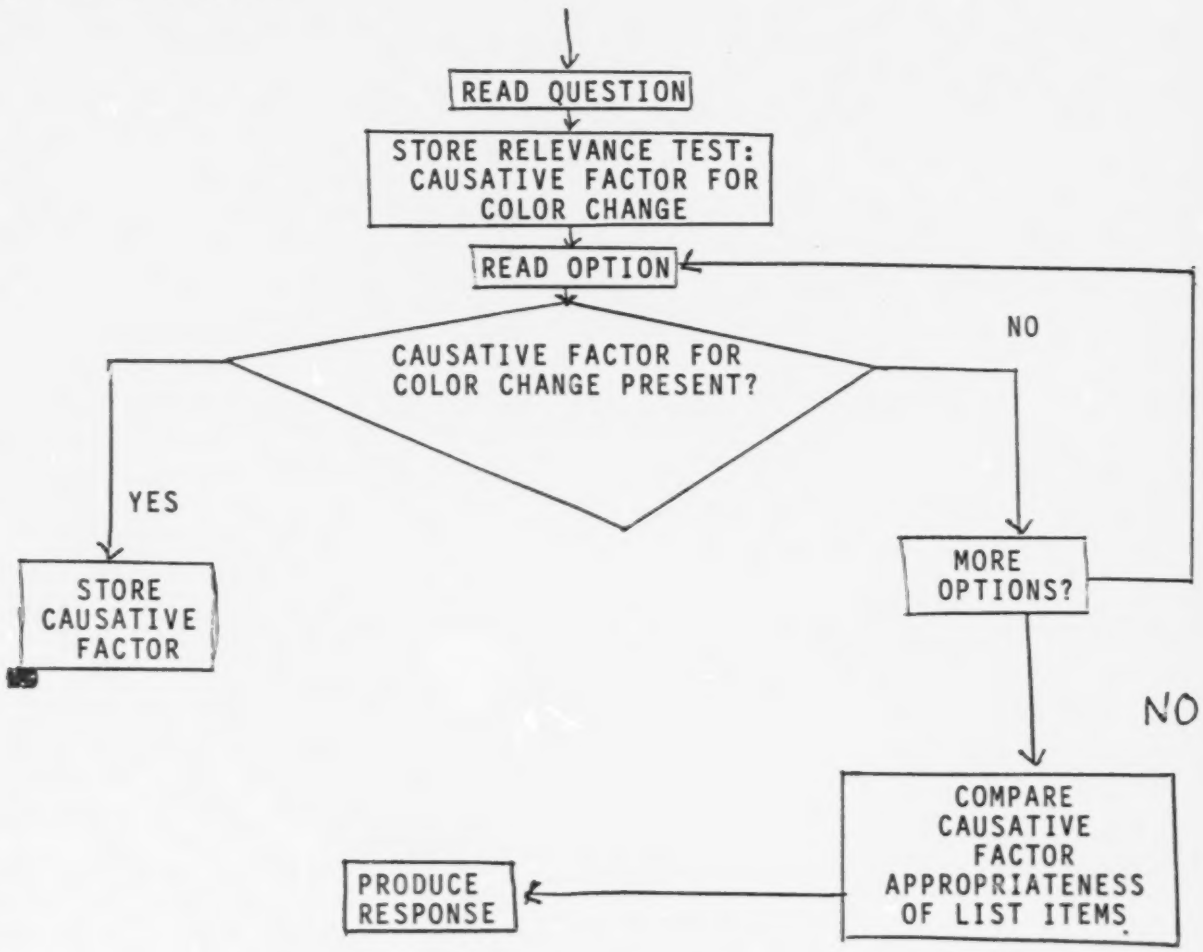


Figure 6

Memory representation generated by the question, "What is the most important factor that accounts for color changes in the ocean as you dive deeper and deeper?"

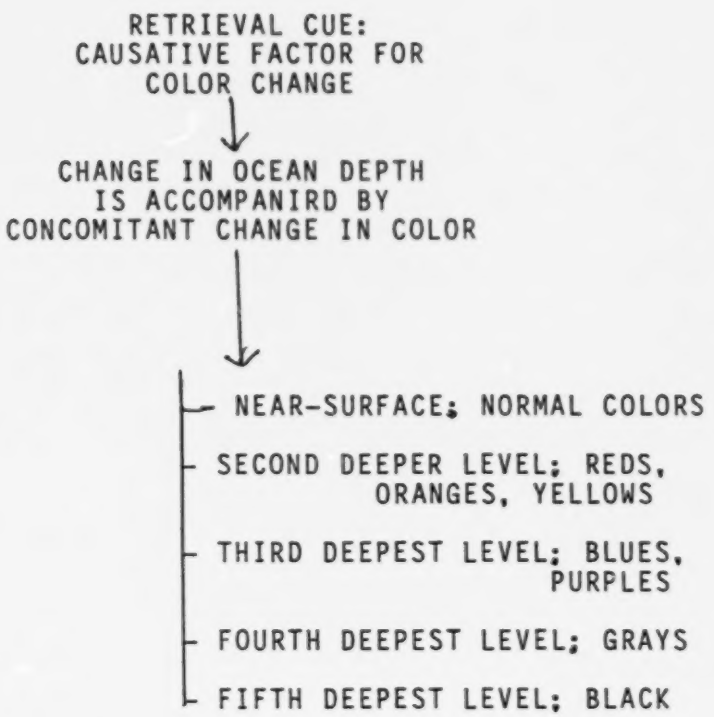
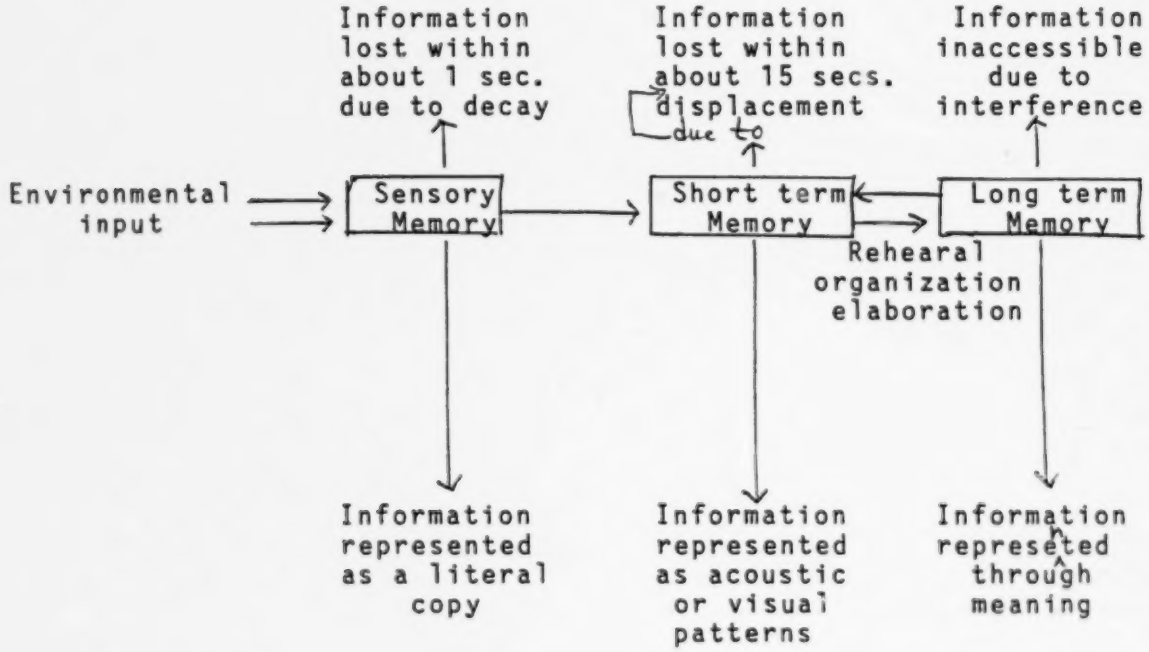


Figure 7

A generalized diagram of the human memory system


Information lost within about 1 sec. due to decay
Information lost within about 15 secs. displacement due to
Information inaccessible due to interference
Environmental input
Sensory Memory
Short term Memory
Long term Memory
Rehearal organization elaboration
Information represented as a literal copy
Information represented as acoustic or visual patterns
Information represented through meaning

(Lerner, Kendall, Miller, Hultsch, and Jensen, 1986, p. 213)